



# 77 All Announcement of Recent Acquisitions. . .

**HSL No. 71-10  
March 12, 1971**



**THIS ISSUE CONTAINS:**

HS-008 243  
HS-008 668 - HS-008 714

HSL No. 71-10 March 12, 1971 HS-008 243, HS-008 668 - HS-008 714

# AN ANNOUNCEMENT OF RECENT ACQUISITIONS

Published Weekly by the National Highway Traffic Safety Administration  
Washington, D.C. 20591

## INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in location citations by the HS-number, the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Category List shown in the Table of Contents. The List is a two-level arrangement consisting of five major subject fields subdivided into 58 subject groups. Documents related directly to the National Highway Traffic Safety

Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration; or for purchase from NTIS (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

## SAMPLE ENTRIES

Subject Category Array —————  
NHTSA Accession no..... HS-800 218 Fld. 5/21; 5/9  
Title of document..... AN INVESTIGATION OF USED CAR  
SAFETY STANDARDS—SAFETY  
INDEX: FINAL REPORT. VOL. 6 -  
APPENDICES G-L  
Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E.  
Guilliams; S. R. Kalin; P. D. Williams  
Corporate author..... Operations Research, Inc., Silver  
Spring, Md., 015000  
Collation —————  
Publication date..... 12 Sep 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190  
523

Abstract..... Appendices G-L to this study of used  
car safety standards include: indeture  
model diagrams for classes I-IV motor  
trucks; degradation, wear, and failure  
data for motor truck classes I-IV; and  
safety index tables for classes I-IV  
motor trucks.

Search terms: Wear/Trucks;  
Failures/Trucks; Used cars; Inspec-  
tion standards (Trucks); Inspection

HS-004 497 Fld. 5/19

### AUTO THEFT—THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement  
Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the  
auto theft problem and comments on  
antitheft devices available now or in  
the planning stage.

Search terms: Theft, Theft protec-  
tion, Stolen cars

## TABLE OF CONTENTS

NOTE: ( ) Numbers in parentheses following certain subject groups indicate the Highway Safety Program Standards (No. 1, and up) and/or Federal Motor Vehicle Safety Standards (No. 101 and up) which may apply to these groups.

|  |                    |
|--|--------------------|
| <b>INTRODUCTION AND</b>                    |                    |
| <b>SAMPLE ENTRIES</b> . . . . .            | Inside Front Cover |
| <b>AVAILABILITY OF DOCUMENTS</b> . . . . . | ii                 |

### NHTSA SUBJECT FIELDS AND GROUPS

|  |   |
|--|---|
| <b>1/0 ACCIDENTS</b> . . . . .               | 1 |
| /1 Emergency Services (11, 15-16)            |   |
| /2 Injuries                                  |   |
| /3 Investigation and Records (10, 14-15)     |   |
| /4 Locations (9, 14)                         |   |
| <b>2/0 HIGHWAY SAFETY</b> . . . . .          | — |
| /1 Breakaway Structures                      |   |
| /2 Communications                            |   |
| /3 Debris Hazard Control and Cleanup (15-16) |   |
| /4 Design and Construction (12, 14)          |   |
| /5 Lighting (14)                             |   |
| /6 Maintenance (12)                          |   |
| /7 Meteorological Conditions                 |   |
| /8 Police Traffic Services (15)              |   |
| /9 Traffic Control (13-14)                   |   |
| /10 Traffic Courts (7)                       |   |
| /11 Traffic Records (10)                     |   |
| <b>3/0 HUMAN FACTORS</b> . . . . .           | 1 |
| /1 Alcohol (8, 14)                           |   |
| /2 Anthropomorphic Data                      |   |
| /3 Cyclists                                  |   |
| /4 Driver Behavior                           |   |
| /5 Driver Education (4, 14)                  |   |
| /6 Driver Licensing (5, 10, 14)              |   |
| /7 Drugs Other Than Alcohol                  |   |
| /8 Environmental Effects                     |   |
| /9 Impaired Drivers                          |   |
| /10 Passengers                               |   |
| /11 Pedestrians (14-15)                      |   |
| /12 Vision                                   |   |

|   |   |
|---|---|
| <b>4/0 OTHER SAFETY-RELATED AREAS</b> . . . . . | 1 |
| /1 Codes and Laws (6)                           |   |
| /2 Community Support (17)                       |   |
| /3 Cost Effectiveness                           |   |
| /4 Governmental Aspects                         |   |
| /5 Information Technology                       |   |
| /6 Insurance                                    |   |
| /7 Mathematical Sciences                        |   |
| /8 Transportation Systems                       |   |

|   |   |
|---|---|
| <b>5/0 VEHICLE SAFETY</b> . . . . .   | 1 |
| * All Federal Motor Vehicle Safety Standards apply to passenger vehicles. An asterisk before a subject group indicates additional types of vehicles to which the indicated standards may apply. |   |
| /1 Brake Systems (102, 105-6, 116)  |   |
| */2 Buses, School Buses, and Multipurpose Passenger Vehicles (102-4, 106-8, 111-3, 116, 205-6, 209, 211)  |   |
| */3 Cycles (3; 108, 112, 116, 205)  |   |
| /4 Design (14; 101-2, 105, 107, 201)  |   |
| /5 Door Systems (201, 206)  |   |
| /6 Fuel Systems (101, 301)  |   |
| /7 Glazing Materials (205)  |   |
| /8 Hood Latch Systems (113)   |   |
| /9 Inspection (1)   |   |
| /10 Lighting Systems (101, 105, 108, 112)   |   |
| /11 Maintenance and Repairs   |   |
| /12 Manufacturers, Distributors, and Dealers  |   |
| /13 Mirrors and Mountings (107, 111)  |   |
| /14 Occupant Protection (15; 201-4, 207-10)   |   |
| /15 Propulsion Systems  |   |
| /16 Registration (2, 10)  |   |
| /17 Safety Defect Control   |   |
| /18 Steering Control System (101, 107, 203-4)   |   |
| /19 Theft Protection (114-5)  |   |
| */20 Trucks and Trailers (102-4, 107-8, 112-3, 116, 205-6, 209)   |   |
| /21 Used Vehicles   |   |
| /22 Wheel Systems (109-10, 211)   |   |
| /23 Windshield-Related Systems (101, 103-4, 107, 205, 212)  |   |

|                                      |    |
|--------------------------------------|----|
| <b>NHTSA DOCUMENTS</b> . . . . .     | —  |
| <b>EXECUTIVE SUMMARIES</b> . . . . . | 14 |

NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the National Highway Traffic Safety Administration, Department of Transportation of any particular product, course, or equipment.

# AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Department of Transportation personnel may borrow copies of publications directly from the NHTSA. Outside the Washington, D.C. area, phone (202) 426-2768. In Washington, D.C. area, use government ID, phone 118-62768. Non-DOT personnel should contact their company or agency libraries for assistance.

Journals cited may be obtained through most research libraries.

Contractors' reports and other documents can usually be obtained as indicated under **AVAILABILITY**. However, there is no certainty that retention copies will be available for more than a limited period after a document is issued.

The more common distribution sources are identified by symbols which are explained below:

**NTIS:** National Technical Information Service (formerly Clearinghouse for Federal Scientific and Technical Information—CFSTI), Springfield, Va. 22151. Order by accession number: *HS, AD, or PB*. Prepayment is required by NTIS (CFSTI) coupon (GPO coupons are not acceptable), check, or money order (made payable to the NTIS). PC (Paper copy; full size original or reduced

facsimile) \$3.00 up; *MF* (microfiche approximately 4x6" negative sheet film; reader required) \$0.95.

**GPO:** Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS [CFSTI] coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

**NHTSA:** National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874).

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report number. Prices given are list; discounts are available to members and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders without payment are subject to a \$1 handling charge.

## IMPORTANT

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS (CFSTI), add DOT/ to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

## SPECIAL NOTICE

### NEW PRICES FOR DOCUMENTS AVAILABLE FROM NTIS

On January 1, 1971, the National Technical Information Service (NTIS) increased the prices for documents in certain categories. These increases were made necessary by increased costs. Prices are now as follows:

#### PAPER COPY

Most documents announced after January 1, 1969, are priced:

|                  |                 |
|------------------|-----------------|
| 1 to 300 pages   | \$3.00          |
| 301 to 600 pages | 6.00            |
| 601 to 900 pages | 9.00            |
| Over 900 pages   | Exception Price |

Two years after announcement, documents having 300 pages or less will have a service charge of \$3.00 added to the announced price. No service charge will be added for documents over 300 pages.

Documents announced prior to January 1, 1969, have a service charge of \$3.00 added to the announced price.

#### MICROFICHE

Microfiche reproduction of documents on a demand basis are priced at 95 cents per document.

## 3/0 HUMAN FACTORS

## 3/1 Alcohol

In the December 11, 1970, issue of HSL No. 70-41 page 3, an error was made in the abstract of HS-008 243 Fld. 3/1; 4/1 entitled,

## ARE DRINKING-DRIVING LAWS ENFORCED?

by Richard Zylman

Published in *The Police Chief* v37 n9 p48-53 (Sep 1970)

The abstract read:

The enforcement level of laws to control drunk driving is very low. A study was made in Grand Rapids to determine how often the violation occurs and how many violators are arrested. It was found that of those who were involved in collisions who had blood alcohol levels of .15% or more, only half were arrested. This is thought to be below average.\* Reasons for low arrest rates are discussed. It is recommended that the problem of alcohol involvement in accidents be redefined in terms of medical, epidemiological, social, and legal aspects, and that community agencies be identified as a response network in a long-range plan for progress.

It should have read:

\* The author states subjectively that this is well above the average for the United States and lists some reasons why arrest rates are generally low.

## 4/0 OTHER SAFETY-RELATED AREAS

## 4/7 Mathematical Sciences

HS-008 668 Fld. 4/7; 4/5; 5/4

## APPLICATION OF FINITE ELEMENT METHOD TO PREDICT STATIC RESPONSE OF AUTOMOTIVE BODY STRUCTURES

by Willy Petersen

Ford Motor Co., Dearborn, Mich., F18600

1971 18p 6 refs  
Report no. SAE-710263

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Applications of the finite element method for analysis of partial and complete body structures are described. Ford Motor Co.'s version of the Structural Analysis and Matrix Interpretive System (SAMIS) computer program provides the capability for a static analysis of structures with over 10,000 degrees of freedom. Special modeling techniques for spot welded structural components have been investigated. Also, methods for quick input data development and effective visual displays of output data are discussed.

Search terms: Finite element method /Static tests; Computer programs /Body tests; Finite element method /Body tests; Degrees of freedom /Static tests; Automobile modeling /Computerized design; Computerized simulation /Static tests

AVAILABILITY: SAE

## 5/0 VEHICLE SAFETY

## 5/1 Brake Systems

HS-008 669 Fld. 5/1; 5/20

## AN INVESTIGATION OF THE BRAKE FORCE DISTRIBUTION ON TRACTOR-SEMITRAILER COMBINATIONS

by Rudolf Limpert

Michigan Univ., Ann Arbor. Highway Safety Research Inst., M40800

1971 13p 22 refs  
Report no. SAE-710044

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

An engineering analysis of tractor-semitrailer braking is presented in terms of the utilization of available

fire-roadway friction. The effects of load transfer on the tandem axle suspension upon braking performance are discussed. The physical relations are derived that allow the determination of an improved brake force distribution among the axles of the combination as a function of the geometric and loading configuration. Tractor-semitrailer operating on our highways have braking efficiencies as low as 60%. Increase in braking performance can be expected provided the brake force distribution is improved. Eliminating the front brakes without changing the base line distribution has an unfavorable effect upon the braking performance of the combination.

Search terms: Braking forces / Tractor semitrailers; Axle loads / Brake performance; Brake performance /Equations; Braking forces / Axle loads

AVAILABILITY: SAE

## 5/4 Design

HS-008 670 Fld. 5/4

## CLAD METALS IN AUTOMOTIVE TRIM APPLICATIONS

by Robert Baboian

Texas Instruments, Inc., Attleboro, Mass., T18600

1971 11p 22 refs  
Report no. SAE-710276

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The behavior of stainless clad aluminum automotive trim has been investigated, using modern electrochemical techniques in laboratory and field service tests. Galvanic protection of paint-damaged auto body and the corresponding sacrificial aluminum behavior with this trim material has been observed in a wide number of applications and conditions. The results obtained with stainless clad aluminum automotive trims are compared with those for other trim materials. The results are explained using modern electrochemical theories.

Search terms: Trim /Stainless steels; Trim /Aluminum; Trim /Field

## 5/4 Design (Cont'd)

HS-008 670 (Cont'd)

tests; Trim /Laboratory tests; Corrosion prevention /Alloys; Steels /Galvanic corrosion; Stainless clad aluminum /Corrosion resistance

AVAILABILITY: SAE

HS-008 671 Fld. 5/4

### TEMPERATURE ENVIRONMENT OF ENGINE COMPARTMENT WIRING

by John F. Gulau

Ford Motor Co., Dearborn, Mich., F18600

1971 6p

Report no. SAE-710093

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Environmental data developed in this study were a valuable guide to material selection and system design of engine compartment wiring. This experience suggests further application of environmental testing to aid in design and material selection. The temperature environment data developed from this study show that engine compartment primary wiring requires temperature resistance in the range 231-337 F. Materials and design improvements have resolved the environmental problems resulting from these temperatures without undue economic burden.

Search terms: Wiring /Heat tolerances; Engine design /Wiring

AVAILABILITY: SAE

HS-008 672 Fld. 5/4

### THE INFLUENCE OF WIND TUNNEL TESTS ON BODY DESIGN, VENTILATION, AND SURFACE DEPOSITS OF SEDANS AND SPORT CARS

by Hans Goetz

Daimler-Benz, Stuttgart (West Germany), D01800

1971 19p

Report no. SAE-710212

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper describes wind tunnel tests with full-scale vehicles and scaled-down models. The influence of design features, air resistance, and lift on driving performance and safety are analyzed. Ventilation systems and air pressure conditions are discussed as well as the precautions taken to reduce surface deposits. The various operating modes of the new wind tunnel developed for Daimler-Benz AG are also described.

Search terms: Wind tunnel tests / Body design; Aerodynamics /Body design; Ventilation /Body design; Air flow /Dirt

AVAILABILITY: SAE

HS-008 673 Fld. 5/4

### ON FATIGUE TESTING OF PASSENGER CAR BODY CONSTRUCTION

by Keiji Kobayashi; Keiji Yamaguchi; Takayuku Ikejiri

Nissan Motor Co. Ltd., Yokohama (Japan), N60600

1971 10p 7 refs

Report no. SAE-710261

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Fatigue tests on a body in white have been made with torsional load and compared with previous results for assessments, where it was difficult to agree with proving ground tests in evaluating the life. Modifying the above mentioned fault, a programmed fatigue test method on the body in white is presented in this paper.

The newly developed programmed fatigue test method is the simultaneous loading of the bouncing and torsional modes to a body in white by an electrohydraulic fatigue testing machine in accordance with the norma-

grammed sprung mass accelerations. Applying this method, the comparatively accurate assessment of proving ground test was made at the condition of the body in white, and the development period for body construction was shortened.

Search terms: Body tests /Fatigue tests; Body tests /Proving ground tests; Body tests /Torsion; Test equipment /Body tests; Automobile bodies; Body tests /Laboratory tests

AVAILABILITY: SAE

HS-008 674 Fld. 5/4

### PLASTIC MODELS FOR DYNAMIC STRUCTURAL ANALYSIS

by W. A. Elliott

General Motors Corp., Detroit, Mich., G06600

1971 11p

Report no. SAE-710262

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Scaled plastic models can be used to predict the dynamic response of complex structures, particularly critical frequencies and mode shapes. The basic advantage in model design analysis is the flexibility in altering initial concepts at early stages of design, which can be accomplished quickly, simply, and at lower costs than would probably be encountered if the structure were fabricated in the prototype material. This paper presents the use of plastic models as a design tool for stamped, welded steel automotive structures and subsequent engineering tests.

Search terms: Dynamic structural analysis /Dynamic models; Dynamic models /Plastics; Steels /Dynamic structural analysis; Body tests /Dynamic models; Vehicle dynamics /Body tests

AVAILABILITY: SAE

HS-008 675 Fld. 5/4

### IMPACT FATIGUE RESISTANCE OF COMMONLY USED GEAR STEELS

by R. A. DePaul

International Nickel Co., Inc., New York, 143200  
971 8p 8 refs  
Report no. SAE-710277

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Gears fail or are damaged on occasion by impact fatigue loading. This study involves an evaluation of the resistance of commonly used gear steels to impact fatigue failure. A specially designed impact fatigue specimen and testing device were used to evaluate engine carburizing steels and three nitriding steels. The relative impact fatigue resistances of the steels are discussed as well as the influences of such heat treatment variables as high carbon potential, high temperature carburizing, and refrigeration. In general, impact fatigue resistance was independent of core strength but improved with increasing nickel content in the nitrided steels as well as the carburized steels. Lowering retained austenite by refrigeration was found to be detrimental to impact fatigue resistance.

Search terms: Gear failures /Impact tolerances; Steels /Impact tolerances; Fatigue tests /Steels; Heat treatment /Steels; Loading tests /Steels; Nitriding /Steels; Carburizing /Steels

AVAILABILITY: SAE

HS-008 676 Fld. 5/4  
FIAT RESEARCH ON SCAVENGING  
OF 2-STROKE LARGE BORE  
ENGINES

by G. Ciliberto  
Fiat S. P. A., Turin (Italy), F10200  
971 23p  
Report no. SAE-710146

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper was prepared after a brief survey of the scavenging systems development, from the birth of the diesel stroke cycle and after a similar report of the research methods. The results are described of the research carried out by Fiat on the scavenging

of the 2-stroke large-bore engines. A report is also given of the results obtained through lab tests at the Fiat Gas Dynamics Labs, and on the full-size engines, which makes it possible to follow the evolution of the Fiat scavenging, mainly during the last 30 years.

These test results were then compared with the ones obtained, the method of research being the same, with other well-known 2-stroke diesel engines scavenging systems.

Search terms: Two stroke cycle engines /Scavenging; Diesel engines /Scavenging; Fiat S. P. A. /Scavenging; Scavenging /Laboratory tests

AVAILABILITY: SAE

HS-008 677 Fld. 5/4  
THE VEGA PLASTIC FLEX FAN

by G. L. Fisher; C. D. Lennon; R. F. Wheaton  
General Motors Corp., Saginaw, Mich., G08100

1971 16p 11 refs  
Report no. SAE-710104

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

A molded one-piece plastic fan with flexible blades was developed for use in automotive vehicles to provide adequate low-speed cooling and reduced noise and horsepower at high speeds. Development was accomplished through an extensive design, testing, and material selection program. The features of light weight, low cost, and good durability were prime considerations for use of the plastic flex fan on Chevrolet's Vega.

Search terms: Fans /Glass fiber reinforced plastics; Fans /Dynamic tests; Fans /Static tests; Glass fiber reinforced plastics /Physical properties; Fans /Vega

AVAILABILITY: SAE

HS-008 678 Fld. 5/4  
EXPERIMENTAL METHODS FOR  
THE STUDY OF TWO-STROKE  
ENGINE SCAVENGING

by C. Martini; M. Oggero

Fiat S. P. A., Turin (Italy), F10200  
1971 12p 13 refs  
Report no. SAE-710145

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The problem of scavenging in any two-stroke engine requires highly sophisticated research methods. To obtain satisfactory results it is necessary to investigate the phenomenon under all its aspects, often resorting simultaneously to different qualitative and quantitative procedures with different degrees of approximation.

The paper describes methods developed by FIAT Gas Dynamics Laboratories and presents, in particular, the fundamental characteristics of a dynamic test bench designed to provide a highly severe simulation of the actual process and to yield considerable technical-economical advantages. This test bench, though devised and used mainly for medium and large engines, is the clearest example of the possibilities derived from grouping all these research programs at a center specialized in the field of fluid dynamics.

Search terms: Two stroke cycle engines /Scavenging; Fiat S. P. A. /Scavenging; Scavenging /Dynamic tests; Test equipment /Scavenging; Continuous flow models /Scavenging

AVAILABILITY: SAE

HS-008 679 Fld. 5/4  
ADHESIVES USED IN AUTOMOTIVE PRODUCTION

by Douglas F. Weyher  
Chrysler Corp., Detroit, Mich., C42600  
1971 9p 6 refs  
Report no. SAE-710106

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper details five types of adhesives used in the automotive industry: evaporation or diffusion, chemically reactive, pressure sensitive, hot melts, and sealants. The adhesives included in each group are listed, along



## 5/4 Design (Cont'd)

HS-008 679 (Cont'd)

with their properties. The author feels that adhesives offer the best method of joining because of their ability to supply a uniform distribution of stresses, an air and water tight seal, vibration and sound dampening, protection from galvanic corrosion, fatigue resistance, along with the ability to join widely dissimilar materials.

Eight tables summarize the various types of adhesive and their uses, bases, applications, and special properties.

Search terms: Adhesives /Properties; Sealers /Properties; Automotive engineering /Adhesives

AVAILABILITY: SAE

HS-008 680 Fld. 5/4

## PERFORMANCE CHARACTERISTICS OF GLASS FIBER REINFORCED PLASTIC INSTRUMENT PANEL SUPPORTS

by Richard J. Giba

General Motors Corp., Dayton, Ohio, G06600

1971 7p 5 refs

Report no. SAE-710025

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper has reviewed the impact and heat distortion characteristics of glass fiber reinforced plastic materials. A presentation of two typical design configurations demonstrated the effects glass fiber level and thickness have on impact readings. Data presented here have shown that, in general, as glass fiber level and/or part thickness increase, both peak g and 3 msec g rise while penetration decreases for both styrene and styrene-acrylonitrile. Also, styrene-acrylonitrile affords higher g loading with decreased penetration than does styrene.

In investigating the heat distortion problem, a new test method was developed. As results from this lab test correlate with results achieved in tests done in Arizona, it has increased our understanding of what to expect from a part in the field. For this reason, our people have found it to be immensely valuable.

In comparing the two materials, it was discovered that the effect of increasing glass fiber level and thickness was to realize a greater improvement in temperature resistance in the test parts of styrene-acrylonitrile than in those of styrene. If only styrene-acrylonitrile parts are considered, increasing thickness gives better results than glass fiber level.

Search terms: Glass fiber reinforced plastics /Instrument panel design; Glass fiber reinforced plastics /Impact tests; Glass fiber reinforced plastics /Thermal factors

AVAILABILITY: SAE

HS-008 681 Fld. 5/4

## VEGA 2300

by L. E. Reuss; C. N. Hughes

General Motors Corp., Detroit, Mich., G06600

1971 45p

Report no. SAE-710150

Presented at Automotive Engineering Congress and Exposition, Detroit, Mich., 11-15 Jan 1971.

Introduction of Chevrolet Vega 2300 models is intended to fill a need for a small, economical, durable, and well styled car built in America to American tastes.

Search terms: Vega /Automobile design; Vega /Chassis design; Vega /Power trains; Compact automobiles /Vega

AVAILABILITY: SAE

HS-008 682 Fld. 5/4

## THE VEGA 2300 ENGINE

by Frederick J. Kneisler; David A. Martens; Roy W. Midgley

General Motors Corp., Detroit, Mich., G06600

1971 27p

Report no. SAE-710147

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The Vega, a new concept in passenger cars, will offer a new and different engine as a result of advances in technology. Research data indicate that the Vega engine should incorporate an overhead camshaft and die-cast aluminum cylinder block without liners. Carburetors are similar to those used on other Chevrolet engines.

This paper will also outline specific design and development factors, which make possible this new powerplant creation.

Search terms: Vega /Engine design; Vega /Exhaust emission control

AVAILABILITY: SAE

HS-008 683 Fld. 5/4

## A NEW RANGE OF 4 CYL IN-LINE SINGLE O. H. C. ENGINES BY FORD IN EUROPE

by J. A. Morgan; D. J. Stojek

Ford Motor Co. Ltd., Brentwood, Essex (England), F20400

1971 31p

Report no. SAE-710148

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper describes a new range of 4 cyl, in-line, single OHC engines produced by Ford in Europe, which is available in three displacements of 1.3, 1.6, and 2.0l. This engine has been developed for high performance output, high-speed operation, and compliance with various exhaust emission regulations. The significant design features highlighted here are the cylinder block, the cylinder head, the intake and exhaust valves, the intake manifolds, and air cleaners with an air intake pre-heat system, all of which are described here. To establish reliability of this new engine, special test runs were made of 300 engines under customer driving conditions in many

countries, covering a total of approximately 10 million km.

Search terms: Overhead camshaft engines /Cylinders; Overhead camshaft engines /Valves; Overhead camshaft engines /Manifolds; Overhead camshaft engines /Exhaust emissions

AVAILABILITY: SAE

HS-008 684 Fld. 5/4

#### A STUDY OF HEAVY-VEHICLE UNDERIDE GUARDS

by Norman J. Deleys; Melvin O. Ryder  
Cornell Aeronautical Lab., Inc., Buffalo, N. Y., C67800

1971 22p  
Report no. SAE-710121

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Twelve full-scale tests have been performed to investigate the underide problem and to determine the effectiveness of several specific guard designs in preventing underide type collisions. Parameters studied include impacting vehicle size and weight, impact velocity, underide guard ground clearance height, rigid and yielding guards, frame and frameless (monocoque) trailer target vehicles, and symmetrical (on-center) and unsymmetrical (off-center) impacts. Data obtained from these tests include deceleration of the impacting automobiles, loading experienced by the underide guards, and high-speed motion pictures of the collision sequences.

In addition to the experimental effort, mathematical modeling of the underide collision was performed using a system of discrete masses and springs to represent the impacting car and truck underide guard. Crash test data were used to define the force-deflection properties for the various springs representing structural components of the automobile. Simulations were run for a series of underide guard force magnitudes and wave forms to examine the effects of underide guard force characteristics on the impacting vehicle.

Search terms: Underide guards / Impact tests; Underide override collisions /Mathematical models; Underide guards /Simulation; Truck trailers /Underide override collisions; Automobiles /Underide override collisions

AVAILABILITY: SAE

HS-008 685 Fld. 5/4

#### AERODYNAMICS OF RACE CARS IN DRAFTING AND PASSING SITUATIONS

by G. F. Romberg; F. Chianese, Jr.; R. G. Lajoie

Chrysler Corp., Detroit, Mich., C42600

1971 8p  
Report no. SAE-710213

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The aerodynamic forces on NASCAR Grand National Race Cars in "drafting" and passing situations are defined, utilizing steady-state wind tunnel test results. The phenomena occurring in these situations are discussed in relation to their effects on handling maneuvers and improved performance. Graphic presentation of data obtained for lift, drag, and yaw supplement the discussion.

Search terms: Aerodynamics / Racing automobiles; Wind tunnel tests /Racing automobiles; Aerodynamics /Passing; Lateral vehicle spacing /Aerodynamics; Following distance /Aerodynamics; Drag /Wind tunnel tests; Yaw /Wind tunnel tests; Lift /Wind tunnel tests

AVAILABILITY: SAE

HS-008 686 Fld. 5/4

#### THE AERODYNAMIC DEVELOPMENT OF THE CHARGER DAYTONA FOR STOCK CAR COMPETITION

by R. P. Marcell; G. F. Romberg

Chrysler Corp., Detroit, Mich., C42600

1970 13p 8 refs  
Report no. SAE-700036

Presented at Automotive Engineering Congress, Detroit, Mich., 12-16 Jan 1970.

The aerodynamic features of the race version of the Charger Daytona, an aerodynamically modified 1970 Charger, are discussed. Effects of major specific modifications are evaluated individually and as a total package. Wind tunnel techniques and philosophy employed in the Daytona Development Program are also discussed.

Search terms: Wind tunnel tests / Dodge Daytona; Aerodynamic configurations /Racing automobiles; Dodge Daytona /Aerodynamic configurations

AVAILABILITY: SAE

HS-008 687 Fld. 5/4

#### VISCOSITY STABILITY OF POLYMER-THICKENED OILS

by N. V. Messina; H. H. Radtke

Rohm and Haas Co., Philadelphia, Pa., R19800

1970 11p 10 refs  
Report no. SAE-700053

Presented at Automotive Engineering Congress, Detroit, Mich., 12-16 Jan 1970.

A continuous, high speed road test has been found to accurately assess the shear stability of motor oils under all types of engine operation. It has also been demonstrated that a methacrylate polymer of sufficiently low molecular weight is completely shear stable under shearing conditions of the high speed road test. A road shear stability survey of commercial multi-graded oils has shown that some oils fail to produce the expected viscosity decrease due to oil oxidation. Preliminary road tests in diesel engines have shown the shear stability losses in polymer-thickened oils similar to those produced in the gasoline engines.

Shear stability studies in automatic transmission fluids by both bench and field tests have shown that this application is substantially more severe

## 5/4 Design (Cont'd)

HS-008 687 (Cont'd)

than the engine in shearing polymeric V.I. improvers.

Search terms: Road tests/Oils; Oils/Shear stability; Methacrylates/Shear stability; Viscosity/Oils; Oxidation/Oils; Diesel engines/Road tests; Viscosity/Stability; Polymers/Oils; Automatic transmissions/Shear stability

AVAILABILITY: SAE

## 5/6 Fuel Systems

HS-008 688 Fld.5/6

### REDUCING HYDROCARBONS AND ODOR IN DIESEL EXHAUST BY FUEL INJECTOR DESIGN

by H. S. Ford; D. F. Merrion; R. J. Hames

General Motors Corp., Detroit, Mich., G06600

1970 8p 8 refs

Report no. SAE-700734

Presented at Combined National Farm, Construction, and Industrial Machinery and Powerplant meetings, Milwaukee, Wisc., 14-17 Sep 1970.

Exhaust hydrocarbons and odor were reduced in Detroit Diesel Series "71" engines by revising the fuel injector tip design. Five injector tips were investigated which had different volumes of uncontrolled fuel below the injector valve. Results are presented to show that exhaust hydrocarbons and odor can be substantially reduced by minimizing the uncontrolled volume of fuel in the injector tip. The hydrocarbon emissions are attributed to uncontrolled fuel being pushed from the tip by expansion of the fuel at elevated temperatures. This conclusion is supported by test results with fuels having different 10% distillation temperatures.

Search terms: Diesel engine exhaust emissions; Hydrocarbons/Diesel engines; Odors/Diesel engines; Fuel injection/Diesel engines; Fuel systems/Diesel engines

AVAILABILITY: SAE

HS-008 689 Fld.5/6

### GENERAL MOTORS MOBILE EMISSION LABORATORY

by W. F. Repphun

General Motors Proving Ground, Milford, Mich., G09600

1971 8p

Report no. SAE-710171

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper describes the General Motors Mobile Emission Laboratory. Information is given on the design criteria and concept, construction features of the trailer, and a discussion of the instrumentation needed to conduct vehicle emission tests.

Primary applications include customer car field surveillance and assistance to assembly plant emission testing. The mobile laboratory has a temperature-controlled area, allowing testing regardless of outside weather conditions. Both concentration and mass emission testing can be done with sufficient flexibility to adapt to future emission standards. A custom built semi-trailer was chosen to fulfill the needs of the mobile lab.

A design study was undertaken to determine the best way all the necessary components could be packaged in a semi-trailer body.

Search terms: Emission tests/Laboratory tests; Measuring instruments/Emissions; Emission standards; Semitrailers/Test facilities; Emissions/Test facilities

AVAILABILITY: SAE

HS-008 690 Fld.5/6

### COMBUSTION AND EMISSION FORMATION IN FUEL SPRAYS INJECTED IN SWIRLING AIR

by N. A. Henein

Wayne State Univ., Detroit, Mich., W09600

1971 12p 37 refs

Report no. SAE-710220

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The purpose of this paper is to develop some concepts for the mechanisms of emission formation during the combustion of liquid fuel sprays injected in swirling air. An emphasis is made on finely dispersed sprays used in open chamber diesel engines. The emissions studied are the unburned hydrocarbons, carbon monoxide, aldehydes, smoke particulates, and oxides of nitrogen.

The spray is considered to be composed of a group of droplets of different sizes. The behavior of these droplets is determined by studying a mathematical model for droplet evaporation and ignition. The spray is then divided into regions, depending on the mechanism of combustion in each region. The emissions formed in each region are examined.

The concepts developed for the formation of the different emissions in the spray are used for a qualitative analysis of some engine experimental data. These data are for the effect of the operating variables on the emission concentration in the exhaust of open chamber diesel engines. In these engines the fuel is injected in swirling air.

Search terms: Fuel combustion/Air injection; Diesel engine exhaust emissions/Reviews; Mathematical models/Diesel engine exhaust emissions; Hydrocarbons; Carbon monoxide; Aldehydes; Smoke; Particulate air pollutants; Nitrogen oxides; Combustion chamber swirl

AVAILABILITY: SAE

HS-008 691 Fld.5/6

### THE CHRYSLER METHOD OF CARBURETOR IDLE FLOW CORRELATION

by R. S. Harris; A. L. Fraccarolli

Chrysler Corp., Detroit, Mich., C42600

1971 11p  
Report no. SAE-710169

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper details the development of idle fuel and airflow measurement transfer systems to correlate data between test stations, including the use of carburetors locked in the idle position. Matched sets of sonic flow nozzles are currently in use at each test location as a basis for defining carburetor idle airflow. Fuel flow, using a test fluid developed specifically for this application, is defined by a simple, accurate weight time calibrator.

The current system requires only the transmittal of data between test locations and is now entering its second year of production application.

Search terms: Idling/Carburetors; Carburetors/Air flow; Carburetors/Fuel flow; Emission control/Idling; Chrysler Corp./Idling

AVAILABILITY: SAE

HS-008 692 Fld. 5/6

PREDICTIONS OF NITRIC OXIDE CONCENTRATIONS IN A SPARK-IGNITION ENGINE COMPARED WITH EXHAUST MEASUREMENTS

by John B. Heywood; Steven M. Mathews; Barbara Owen

Massachusetts Inst. of Tech., Cambridge, M15000

1971 11p 18 refs  
Report no. SAE-710011

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

A theoretical model which predicts exhaust nitric oxide concentrations in a spark-ignition engine is described. The essential features of the model are a kinetic scheme for nitric oxide formation and a thermodynamic analysis of the burnt and unburnt gases during and after combustion. Predictions are compared with exhaust nitric oxide concentrations measured on single-cylinder CFR engines. For fuel-lean and stoichiometric mixtures, predictions are within a factor of 2 below

the experimentally measured values. The discrepancy for fuel-rich mixtures increases to about an order of magnitude at an equivalence ratio of 1.4. The effects of uncertainty in kinetic rate constants, temperature predictions, cycle-to-cycle variations, and burnt gas mixing on the model are explored.

Search terms: Nitric oxide/Single cylinder engines; Exhaust emission tests/Models; Fuel composition/Nitric oxide; Exhaust gases/Temperature; Spark ignition engines/Nitric oxide

AVAILABILITY: SAE

HS-008 693 Fld. 5/6

WHY INTAKE CHARGE DILUTION DECREASES NITRIC OXIDE EMISSION FROM SPARK IGNITION ENGINES

by Ather A. Quader

General Motors Research Labs., Warren, Mich., G10800

1971 12p 14 refs  
Report no. SAE-710009

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This study was undertaken to develop a better understanding of how intake charge dilution by various gases affected nitric oxide (NO) emission from a single-cylinder spark ignition engine. Carbon dioxide, nitrogen, helium, argon, steam, and exhaust gas were individually added to the intake charge of a propane-fueled, single-cylinder engine operated at constant speed and load. Nitric oxide emission was reduced in all cases. The gases with higher specific heats gave larger NO reductions. The product of diluent flow rate and specific heat correlated with NO reduction. The effects of diluents on calculated combustion temperature, mbt spark timing, and fuel consumption are also presented and discussed.

Search terms: Nitric oxide/Charge dilution; Single cylinder engines/Nitric oxide; Spark timing/Charge dilution; Charge dilution/Specific

heat; Fuel economy/Charge dilution; Exhaust emission control

AVAILABILITY: SAE

HS-008 694 Fld. 5/6

EFFECTS OF CHARGE DILUTION ON NITRIC OXIDE EMISSION FROM A SINGLE-CYLINDER ENGINE

by J. D. Benson; R. F. Stebar

General Motor Research Labs., Warren, Mich., G10800

1971 12p 11 refs  
Report no. SAE-710008

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The effects of charge dilution on the exhaust emission of nitric oxide (NO) from a single-cylinder engine were evaluated over a range of engine design and operating parameters.

Nitric oxide emission decreased as much as 70% as charge dilution fraction (volume fraction of product gases in the combustion chamber prior to ignition) was increased from 0.065 to 0.164 due to increased valve overlap, external exhaust recirculation, and reduced compression ratio. With these three variables, NO emission was strongly dependent on charge dilution fraction, but was independent of the specific method used to change charge dilution. Other variables such as valve overlap position, spark timing, and exhaust pressure also affected charge dilution and NO emission, but the relationship between charge dilution fraction and NO emission for these variables was not consistent.

Search terms: Nitric oxide/Charge dilution; Single cylinder engines/Nitric oxide; Exhaust gas recirculation/Nitric oxide; Compression ratio/Nitric oxide; Spark timing/Nitric oxide; Valve timing/Nitric oxide; Exhaust emission control

AVAILABILITY: SAE

HS-008 695 Fld. 5/6

# A MATHEMATICAL MODEL FOR THE MASS TRANSFER AND COMBUSTIBLE MIXTURE FORMATION AROUND FUEL DROPLETS

by N. A. Henein

Wayne State Univ., Detroit, Mich., W09600

1971 8p 14 refs

Report no. SAE-710221

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The vapor diffusion and the combustible mixture formation around evaporating fuel droplets are studied. The formulas derived for the droplet temperature and vapor concentration profiles take into consideration the unsteady period before the droplet reaches its equilibrium temperature. In this model the droplet is assumed to be suddenly brought into contact with a high temperature oxidizing atmosphere.

The ignition delay is considered equal to the period of time from the start of heating up to the time of formation of a stoichiometric mixture at the ignition location around the droplet. Computations are made for the temperature history, concentration history, and the ignition delay for iso-octane droplets evaporating in air. The comparison between the results of the present model and previous experimental results showed favorable agreement.

Search terms: Fuels/Mass transfer; Mass transfer/Mathematical models; Ignition delay/Fuels; Ignition temperature/Fuels; Fuel combustion/Mathematical models; Fuel combustion/Equations

AVAILABILITY: SAE

## 5/14 Occupant Protection

HS-008 696 Fld. 5/14

# DYNAMIC PROBLEMS WITH AN AIR BAG RESTRAINT SYSTEM

by J. A. Pflug

Ford Motor Co., Dearborn, Mich., F18000

1971 6p 8 refs

Report no. SAE-710021

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Crash testing has revealed dynamic problems with present designs for air bag passive restraints which must be resolved. Out-of-position occupants can restrict deployment of the air bag or affect its restraint action. In rollover and side impact accidents, today's air bag offers only minimal restraint. Accordingly, it appears essential to use the lap belt, in combination with air bags, to achieve an improved restraint system over current systems when usage rates and effectiveness are considered. The noise level created by air bag actuation may exceed tolerance levels in some humans. Inadvertent deployment of air bags could compromise the driver's control of the vehicle. These and other technical problems must be resolved before such systems are furnished in automobiles to be sold to the public.

Search terms: Air bag restraint systems/Children; Air bag restraint systems/Seat occupation; Rollover accidents/Air bag restraint systems; Air bag inflation pressure; Side impact collisions/Air bag restraint systems; Air bag restraint systems/Startle effect; Air bag restraint systems/Noise tolerances

AVAILABILITY: SAE

HS-008 697 Fld. 5/14

# DIGITAL SIMULATION OF AN INFLATABLE SAFETY RESTRAINT

by R. A. Hammond

Cornell Aeronautical Lab., Inc., Buffalo, N. Y., C67200

1971 9p

Report no. SAE-710019

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The simulation described in this paper is intended to provide a flexible and

economical tool for designing and evaluating inflatable safety restraints. It should be useful both for parameter studies and as a supplement to experiment. This two-dimensional digital simulation is now being completed as part of the CAL/AMA Two-Dimensional Crash Victim Simulation. This paper discusses the assumptions made to formulate the model, sketches the simulation organization, and outlines the three major submodels—thermodynamics, bag shape, and restraint forces.

Search terms: Air bag restraint systems/Computer simulation; Digital computers; Air bag restraint systems/Force; Air bag restraint systems/Thermodynamics; Air bag inflation pressure

AVAILABILITY: SAE

## 5/15 Propulsion Systems

HS-008 698 Fld. 5/15

# POWER REQUIREMENTS OF ELECTRIC VEHICLES

by G. F. Herbert; A. E. Anderson

Ford Motor Co., Dearborn, Mich., F18600

1971 20p 12 refs

Report no. SAE-710238

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

An analytical investigation has provided a new and useful procedure for evaluating the peak power requirements of a vehicle, based upon the desired levels of accelerative performance and the vehicle usage, that is, city, suburban, or highway applications. These power requirements have been used to determine the required weight of the vehicle power source, based upon its effective power density and the propulsion system efficiency. A computer solution to the one-dimensional equation of motion of a vehicle with a non-linear input was used to predict vehicle performance. To illustrate potential applications of this method, examples of a battery-electric drive and a hybrid (engine-battery) drive system were considered

for a compact-size car with performance equivalent to today's compacts.

Search terms: Electric vehicles / Power; Electric vehicles / Acceleration; Electric vehicles / Vehicle usage; Vehicle weight / Electric vehicles; Performance characteristics / Electric vehicles; Equations of motion / Performance characteristics; Computerized simulation / Performance characteristics; Hybrid automobiles / Performance characteristics; Electric automobiles / Performance characteristics; Compact automobiles / Performance characteristics

AVAILABILITY: SAE

HS-008 699 Fld. 5/15

#### DUAL BATTERY ELECTRIC POWERPLANT

by Earl H. Hietbrink; Gary L. Winebrener; Romeo R. Witherspoon

General Motors Research Labs., Warren, Mich., G10800

1971 9p 7 refs  
Report no. SAE-710234

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

As part of a continuous program to develop and evaluate advanced battery concepts for vehicle propulsion, General Motors has built and operated a dual battery test vehicle, the XEP, to explore the potential and problems of a mechanically rechargeable zinc-air energy battery. The zinc-air battery is economically attractive and has sufficient power density to have potential as a power source for low performance vehicles and to be used as an energy battery augmented by a power battery as a dual battery power source for higher performance vehicular applications.

Although the XEP vehicle was operated successfully, it was concluded that a mechanically rechargeable zinc-air battery was not practical. The encouraging performance and attractive economic features of the zinc-air battery provide the justification for continuous research and development

efforts to evolve an electrically rechargeable battery that could have considerable potential as a practical power source for specific vehicular applications.

Search terms: Dual battery systems; Electric vehicles; Zinc air batteries / Battery charging; Performance characteristics / Zinc air batteries; Experimental vehicles / Dual battery systems

AVAILABILITY: SAE

HS-008 700 Fld. 5/15; 5/6

#### ELECTRIC CAR AND AIR POLLUTION

by Paul D. Agarwal

General Motors Research Labs., Warren, Mich., G10800

1971 22p 24 refs  
Report no. SAE-710190

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Emissions of air pollutants at the powerplants to generate the energy required to charge the batteries for electric cars are calculated and compared with those from IC engine automobiles that will meet emission standards proposed by the U.S. Department of Health, Education, and Welfare. The relative effect of these two types of vehicles on the environment will depend on the degree of emission controls imposed on electric powerplants. The data based on present information shows that electric cars would result in more pollutants than gasoline powered vehicles with emission controls, and hence, aggravate the air pollution problem on an area wide basis. How this picture may change in the next thirty to fifty years is also examined.

Search terms: Power plant air pollution; Electric automobiles / Battery charging; Electric automobiles / Air pollution; Internal combustion engines / Air pollution; Emission standards / Power plants

AVAILABILITY: SAE

## 5/18 Steering Control System

HS-008 701 Fld. 5/18; 5/20

#### IH AIR SUSPENSION

by W. S. Locke

International Harvester Co., Chicago, Ill., 141400

1970 17p  
Report no. SAE-700869

Presented at National Combined Fuels and Lubricants and Transportation meetings, Philadelphia, Pa., 4-6 Nov 1970.

A new truck air suspension system has been developed which provides excellent roll stability and articulation capability without compromising the exceptionally soft ride characteristics of air suspension. The concurrent realization of roll stability and articulation capability for tandem driving axles has been achieved by designing a nearly rigid, roll resisting, rear axle, to be used in conjunction with a freely articulating, forward rear axle. This principle applies equally well for single driving axle vehicles, where the rigid axle provides the same roll stability while articulation, not really a problem on single axle vehicles, is provided by frame and front axle suspension flexibility.

Search terms: Air suspension systems / Trucks; Rear axles / Trucks; Truck stability / Roll; Front axles / Trucks; Drive axles / Trucks

AVAILABILITY: SAE

HS-008 702 Fld. 5/18

#### PERFORMANCE TASKS AS MEASURES OF VEHICLE HANDLING QUALITIES AT THE LIMIT OF PERFORMANCE

by M. R. Belsdorf; R. S. Rice; K. D. Bird

Cornell Aeronautical Lab., Inc., Buffalo, N. Y., C67200

1971 9p  
Report no. SAE-710081

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

## 5/18 Steering Control System (Cont'd)

HS-008 702 (Cont'd)

Performance tasks have been developed and used to give objective measures of vehicle handling at the limit of performance. Tasks discussed include two obstacle avoidance maneuvers, cornering on a bumpy surface, and braking tests. These tasks excite various degrees of freedom of the vehicle being tested in different combinations and degree. The tasks are shown to be practical and to employ simple instrumentation. Skilled drivers were used; it is shown that consistent results are obtained with excellent repeatability. Discrimination between vehicles, or in the cases presented, with varying degrees of component degradation in the same vehicle, is excellent. It is concluded that it is possible to use performance tasks to obtain objective measures of handling performance and that the techniques presented here are applicable to design and evaluation problems.

Search terms: Vehicle handling / Test drivers; Driving tasks; Cornering / Performance tests; Braking / Performance tests; Accident avoidance / Performance tests; Fixed objects / Accident avoidance

AVAILABILITY: SAE

HS-008 703 Fld. 5/18; 5/1

## MEASUREMENT OF VEHICLE RESPONSE IN SEVERE BRAKING AND STEERING MANEUVERS

by Howard Dugoff; Leonard Segel; R. D. Ervin

Michigan Univ., Ann Arbor. Highway Safety Research Inst., M40800

1971 21p 14 refs

Report no. SAE-710080

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15

A set of performance characteristics postulated to reflect the precrash safety quality of the motor vehicle has been defined. Methods of testing and data analysis that provide objective and discriminating procedures for measuring these safety-relevant characteristics have been developed and demonstrated. An automatic controller has been developed and has permitted the investigators to conduct severe steer and brake maneuvers heretofore impossible due to the limitations of the human controller. The latter development is deemed to be a noteworthy advance in motor vehicle test technology.

Search terms: Braking / Safety research; Steering / Safety research; Turning / Braking; Vehicle handling / Test facilities; Lane changing / Vehicle handling; Vehicle handling / Safety research; Vehicle handling / Mathematical analysis

AVAILABILITY: SAE

## 5/20 Trucks and Trailers

HS-008 704 Fld. 5/20; 5/15

## GAS TURBINE POWERED TRUCKS ON THE JOB

by Norman B. Chew

Freightliner Corp., Portland, Oreg., F27000

1970 8p

Report no. SAE-710269

Presented at SAE Detroit Section meeting, 1970.

Turbine development for the trucking industry has made major progress since Freightliner built its first turbine truck in 1965 using simple split shaft turbines manufactured by Boeing and later by Caterpillar. Improvements in the turbine engine include regenerators to recover waste heat from the exhaust system and a means to improve part throttle efficiencies with the features of power transfer and variable geometry. These features also have the facility of providing retarding which will help the overall vehicle performance along with making the engine more adaptable to conventional

Search terms: Gas turbine trucks / Performance characteristics; Exhaust systems / Gas turbine trucks; Transmissions / Gas turbine trucks; Fuel systems / Gas turbine trucks; Electric systems / Gas turbine trucks

AVAILABILITY: SAE

HS-008 705 Fld. 5/20; 5/15

## A HIGH SPEED DRIVETRAIN CONCEPT FOR GAS TURBINE POWERED TRUCKS

by Myron M. Schall

Dana Corp., Toledo, Ohio, D03000

1971 12p

Report no. SAE-710200

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The availability of the gas turbine engine for the heavy duty highway tractor application will place greater emphasis on utilizing smaller and lighter drivetrain components. This paper describes the development of components for a 10,000 rpm drivetrain from the engine to the driving wheels. The performance of the vehicle has proven the technical feasibility of a high speed drivetrain concept for gas turbine powered trucks which may eventually be commercially available.

Search terms: Gas turbine engines; Gas turbine trucks / Drivetrains; Gas turbine trucks / Truck tractors

AVAILABILITY: SAE

## 5/22 Wheel Systems

HS-008 706 Fld. 5/22; 2/4

## INVESTIGATION OF TIRE-ROAD TRACTION PROPERTIES

by F. D. Smithson; F. H. Herzegh

General Motors Proving Ground, Milford, Mich., G09600; Goodrich (B. F.) Tire Co., Akron, Ohio, G24000

1971 12p

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Tire traction performance is dependent on both the tire design and the road surface on which the tire is operated. Measurement of a tire's traction capabilities is indicative of the performance of the tire-road surface combination. Therefore, it is important that the surfaces used to evaluate tire traction capabilities react in a manner similar to those on which the tire will operate.

This paper presents a method for categorizing road surface traction properties by evaluating the traction performance of road surfaces when tested with a series of special tires. Data are presented on a series of road surfaces and recommendations are made for traction test surface design.

Search terms: Tire traction /Tire design; Tire road contact forces; Road surfaces/Tire traction; Pavement tests; Wet road conditions /Tire traction

AVAILABILITY: SAE

HS-008 707 Fld. 5/22

# TIRE UNIFORMITY AND CORRELATION TO VEHICLE RIDE

by L. A. Gursky

Ford Motor Co., Dearborn, Mich., F18600

1971 5p

Report no. SAE-710086

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Tire uniformity grading machines have become an indispensable tool used by all original equipment tire producers for screening tires to acceptable levels for automobile manufacturers. However, so many machines and procedures have been used by tire manufacturers in the past that correlating tire uniformity levels from various sources and determining the effect of variations on the ride quality of

prehensive programs to further investigate the correlation of the various non-uniformity parameters and their individual and compound effects upon ride quality. Investigations are also being conducted to determine correlations of high-speed tire uniformity to low speed and vehicle ride. These and other efforts are directed toward an eventual development of a mathematical description of tire-vehicle behavior.

Search terms: Tire uniformity / Vehicle riding qualities; Tire uniformity /Test equipment

AVAILABILITY: SAE

HS-008 708 Fld. 5/22

# GENERAL MOTORS PROVING GROUND TIRE CORNERING TEST VEHICLE

by A. D. Cortese; C. S. Rockafellow

General Motors Proving Ground, Milford, Mich., G09600

1971 12p

Report no. SAE-710092

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper discusses the prototype General Motors Proving Ground Tire Cornering Traction Test Vehicle; a device now under development to measure cornering traction and cornering-braking traction on test road surfaces, as well as real world roads.

The equipment will measure cornering traction capabilities as influenced by dynamic slip angle, camber angle, braking, speed, road surface and road surface contaminants. Comparisons are made with data obtained from laboratory equipment and the PG Model II Friction Traction Trailer.

Search terms: Data processing /Tire tests; Tire test equipment; Tire road conditions /Tire tests; Camber /Tire tests; Speed /Tire tests; Tire slip motion; Cornering /Tire traction; Braking /Tire traction; Transducers /

HS-008 709 Fld. 5/22

# REDUCTION OF TIRE NONUNIFORMITIES BY MACHINE TECHNIQUES

by James Hamburg; John Horsch

General Motors Research Labs., Warren, Mich., G10800

1971 10p 6 refs

Report no. SAE-710089

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

Machining techniques that reduce the amplitude of low-speed radial uniformity measurements and their effects on smooth-road vehicle vibrations were investigated. The methods ranged from simple concentric and eccentric truing suited for service work to a servo-controlled tire-wheel assembly measuring and corrective machine installed at an auto assembly plant. These methods produce significant reduction of the measured low-speed radial uniformity. Corresponding vehicle evaluation showed significant reduction of smooth-road shake—a 1 per wheel revolution vibration—but little change of higher order vibrations. The simplicity of eccentric truing, combined with its predictable reduction of shake, provides a service fix for smooth-road shake.

Search terms: Vehicle riding qualities /Tire performance; Vehicle riding qualities /Wheel performance; Tire forces; Tire uniformity /Test equipment; Wheel vibration

AVAILABILITY: SAE

HS-008 710 Fld. 5/22

# THE VEHICLE APPLICATION OF TIRE/WHEEL ROLLING SMOOTHNESS CONTROLS

by C. W. Daberkoe

General Motors Corp., Detroit, Mich., G06600

1971 5p

Report no. SAE-710088

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.



## 5/22 Wheel Systems (Cont'd)

### HS-008 710 (Cont'd)

Increased emphasis on high speed vehicle rolling smoothness may be attributed to the growing network of Interstate highways.

Tire/wheel vibration inputs which disturb highway rolling smoothness are measurable in terms of force variation of the tires, and runout variation of the wheels.

New techniques are available to screen and correct for excessive tire and wheel variations. These techniques apply to the tires or wheels individually; or to the tire/wheel assembly. Tire/wheel assembly screening and tire honing correction is a unique method which has been implemented at Cadillac Motor Car Division. This improvement was adopted to enhance the luxury ride of the Fleetwood Eldorado vehicle during the 1970 model run.

Search terms: Vehicle riding qualities/Wheel performance; Vehicle riding qualities/Tire performance; Wheel vibration; Tire vibration; Tire force measurement; Tire honing; Tire forces

AVAILABILITY: SAE

The passenger car windshield wiper system design is very dependent upon the vehicle styling. As such, wiper systems are continually being revised or redesigned to accommodate new styling themes and incorporate engineering improvements. The design process is discussed from the initial feasibility phase to the final production release of detailed drawings. Since the application of computers to wiper design has been covered in other articles, the classical approach with little computer usage is emphasized. The various possible system configurations are reviewed in addition to a general discussion of the wipe pattern design, the linkage design, and the considerations for recessed or concealed wiper parking.

Search terms: Windshield wiper design; Concealed windshield wipers; Feasibility studies /Windshield wiper design

AVAILABILITY: SAE

### HS-008 712 Fld. 5/23

#### WINDSHIELD WIPER SYSTEM PRODUCT DEVELOPMENT AND TESTING

by Paul D. Arbogast

Chrysler Corp., Detroit, Mich.,  
C42600

1971 11p

Report no. SAE-710256

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

This paper presents an overview of the windshield wiper system development and testing required to achieve desired performance levels. Specific tests for the system and individual components are discussed, along with methods for coordinating the various development phases and the interaction with groups outside the engineering field.

Search terms: Windshield wiper design; Windshield wipers / Performance tests; Windshield wiper blades

AVAILABILITY: SAE

### HS-008 713 Fld. 5/23

#### WINDSHIELD WIPER LINKAGE ANALYSIS

by Harkrishan Singh

Ford Motor Co., Dearborn, Mich.,  
F18600

1971 10p

Report no. SAE-710254

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The kinematic analysis methods computer program that has been used by Ford Motor Co. to evaluate mechanisms for the past four years has been modified to generate performance curves for windshield wiper linkages directly using a Calcomp Plotter. Problems such as stalling, "jerky" operation, and excessive phase lag between wipers can be detected early in the design stages by careful evaluation of the curves.

Search terms: Kinematics / Windshield wipers; Windshield wiper design /Computerized design; Performance characteristics /Windshield wipers; Computer programs

AVAILABILITY: SAE

### HS-008 714 Fld. 5/23

#### WINDSHIELD WIPER SYSTEM MOTOR SELECTION AND APPLI- CATION

by Donald H. Baumhart; Joseph J. Augustine

Ford Motor Co., Dearborn, Mich.,  
F18600

1971 11p

Report no. SAE-710257

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

The selection of a motor for a windshield wiper system requires a full analysis of all system variables, in addition to strict adherence to tests and development procedures. Following a well-programmed procedure will assure complete and adequate windshield wiper prime mover selection and successful application.

## 5/23 Windshield-Related Systems

### HS-008 711 Fld. 5/23

#### WINDSHIELD WIPER SYSTEM DESIGN

by Dale M. Cunningham

Chrysler Corp., Detroit, Mich.,  
C42600

1971 10p 5 refs

Report no. SAE-710255

Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

MARCH 12, 1971

VEHICLE SAFETY

There are five basic steps discussed:

1. Determination of wiper parameters.
2. Motor performance.
3. System load determination.

4. Calibration and matching of wiper motor to system.
5. Testing and evaluating.

Search terms: Windshield wipers /

Motors; Performance tests /Motors;  
Calibration /Motors

AVAILABILITY: SAE



# executive summary

## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

### SPEED AND ACCIDENTS

The purpose for this project was to collect and analyze accident and speed data that would quantify the correlation between speed deviation and accident rates, and to determine interactions between speed deviation and other factors precipitating accidents including environmental traffic flow and driver characteristics.

Contract FH-11-6965  
Research Triangle Institute  
Research Triangle Park,  
North Carolina 27709  
DOT/HS-800 297 Vol. I Summary Report  
DOT/HS-800 298 Vol. II Detailed Report

Award Amount: \$334,899.00  
Date Report Due: 6/30/70  
Date Report Rec'd: 8/3/70  
Date Released: 10/27/70  
PB-195 016  
PB-195 017

### MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

#### • Accidents

- Over a thirteen month period, 200 accidents, involving 353 vehicles were investigated on the state roads of Monroe County, Indiana. In addition, 94 accidents which occurred on county roads were investigated. These accidents are listed in the report but are not included in the involvement rate analysis because of insufficient volume-time information on county roads.
  - The results of the study indicate a U-shaped relationship between involvement rate and speed deviation. The table in section 3 of the summary report gives the numerical values of the involvement rate as a function of speed deviation for all state roads in Monroe County, Indiana. The rates were obtained after eliminating those accidents which involved a turning maneuver.
  - The results confirm the hypothesis that slow driving as well as fast driving increases the likelihood of being involved in an accident. However, the curvature of the U-shaped relationship in the involvement rate is not nearly as pronounced as that given in a previous study by D. Solomon
- entitled, "Accidents on Main Rural Highways, Related to Speed, Driver and Vehicle," U.S. Department of Commerce, July 1964.
- Forty-four percent of all accidents and 56% of the involvements, involved at least one vehicle which was either in a turning maneuver or influenced by another vehicle which was in the process of turning.
  - Out of 183 drivers only 39 or 21% having seat belts available were using them.
  - There is a speed deviation and age interaction, that is, younger drivers occur more frequently in the high-speed deviation class and older drivers in the low-speed deviation class.
  - The analysis of a tabulation of accidents within the time period allowed on Highway 37, indicates that even though Highway 37 North appears to a driver to be a safer highway than 37 South, the likelihood of being involved is greater due to the multiple vehicle accident. The tabulation was recorded

for single accidents involving only one vehicle, and multiple accidents such as head-on rear-end and side impacts.

#### ● Traffic Flow

Utilizing radar and the computer-sensor system data, traffic flow characteristics (mean speed, speed variability, and volume) were examined for each of the roads included in the study. For Highway No. 37, these characteristics have been examined with respect to changes over time. Some general conclusions resulting from these analyses are:

- Large differences in mean speeds exist among the various roads included in the study. This was anticipated in view of differences in road geometry, surface, type, width, topography, concentration of population, etc., existing within the road network.
- Mean speeds at night and especially the early morning hours are consistently higher than daytime mean speeds.
- Mean speeds are generally higher for dry roads than for wet roads. There were stations where wet roads exhibited mean speeds equal to or even greater than dry roads; however, this could be a situation where rain had just ended and there was good visibility, but the road was still wet.
- Speed variability is relatively stable over the entire road network system.
- Speed variability is generally greater, but by only a small amount, during night driving as compared to daytime driving.
- Three linear prediction models consisting of 3, 6, and 15 variables were examined to determine those variables which explain best the variation in hourly mean speeds. Of all the variables studied, volume of vehicles in same direction is the most important single factor.
- Speed distributions are adequately described by the normal distribution.
- One approach for evaluating the effectiveness of countermeasures (C/M) pertaining to speed deviations is described. For given speed distribution and likelihood of accident involvement one can estimate the maximum reduction possible in overall likelihood, ignoring intersection turning maneuver accidents, which can be achieved by particular countermeasure programs. The effectiveness of a program to reduce the involvement rate must be considered relative to the maximum possible reduction, and then the potential value of a particular C/M program can be estimated.
- There was not sufficient data available to allow a full analysis but it appears that the study reinforces the setting of speed limits at the 85th percentile speed. The drivers having speeds between the mean and two standard deviations above the mean are definitely in a low involvement group. Speeds at two standard deviations above the mean correspond to approximately the tolerance level allowed by police agencies. Thus the higher level of enforcement occurs when the accident-involvement likelihood function begins to increase significantly resulting in a more cost effective C/M.
  - If minimum speed limits are set a similar argument would lead to the conclusion that the limit should be placed at about the 15th percentile speed with enforcement at about 5th percentile.

#### ● Computer-Sensor System

- The Computer-Sensor System (CSS) has provided data on speed, density, headways, and mix of vehicles on the roadway during the time of the accident in a very satisfactory manner. Data are now available that have not been previously collected regarding the overall traffic parameters in a traffic stream containing accident involved vehicles (AIV's).
- The CSS is capable of detecting either the AIV or the platoon of vehicles containing the AIV approximately 25 percent of the time with high confidence. This capability is dependent on some accident investigation which identifies the particular vehicles, location and time of the accident, the statements of witnesses concerning unusual speeds and relative positions of vehicles having extreme lengths.
- The standard deviations of the estimated vehicle speeds and lengths as recorded by the CSS are approximately 1 mph and 1 foot respectively.

can provide data for better understanding of traffic flow behavior. It is believed no data on a two-lane road such as State Road No. 37 exists to the extent that they are available from this data collection effort.

- For the 22 weeks beginning with June 23, 1969, through November 23, 1969, the weekly system availability ranged from about 57% to 96%, adjusting for scheduled maintenance of four hours per week. System availability is the proportion of up-time for the system to total time, in this case 164 hours per week. During this period of time considerable downtime was scheduled for system analysis, expansion, and improvements. During three weeks the availability exceeded 90% indicating that it is capable of high level performance.

## ● Conclusions

- The major conclusion resulting from this project is that the likelihood of being involved in an accident is increased by a factor of about 10 if one is driving at speeds which deviate considerably, approximately 15 mph, from the mean speed of the traffic. Because of a study performed early in the investigation with respect to the error in estimating involvement rates as a function of speed deviations\*, it is necessary to subdivide speed deviation values into a small number of intervals (5 are used in this study) to minimize the effect of the error in estimating the speeds of accident involved vehicles. The conclusion above, with reference to the speed deviation, is dependent on how finely one can subdivide the range of speed deviation values. The likelihood of involvement varied from about 6 to 21 accidents per million vehicle miles for the high-speed deviations compared to about unity for the low-speed deviations.

\*S. B. White, Jr. and A. C. Nelson, Jr. (1970) "Some Effects of Measurement Errors in Estimating Involvement Rate as a Function of Deviation from Mean Traffic Speed" - June issue of Journal of Safety Research.

- The Computer-Sensor System provides an excellent method for collecting data concerning traffic flow characteristics during the occurrence of an accident. Some

accuracy and precision of the data; furthermore, quality control procedures need to be introduced to maintain collection of good quality data.

- The Computer-Sensor System is a costly system if its only purpose is to identify accident-involved vehicles and to provide estimates of these speeds. For this project its purpose was twofold; in addition to estimating the speeds of the accident-involved vehicles, it is to estimate the mean speed, volume, and traffic mix, using effective vehicle length estimates. It is believed that such information is not available from any other traffic flow data collection system.

## ● Recommendations

- It is suggested that an investigation be made of an analog device in conjunction with the present computer-sensor system in order to assist in the identification of vehicles, for example, the wave forms obtained from the magnetic loop sensors could be correlated with vehicle types.
- Portable sensors should be used to study traffic flow in the vicinity of intersections and at traffic signals. In the latter case, information is needed concerning the traffic flow as the vehicles depart from the control signal.
- A great deal of traffic flow data on a two-lane road is available on magnetic tape as a result of the data collection activity of this project. Information concerning vehicle speeds, lengths, direction of travel and headway are available for further analysis. In addition, a weather log has been maintained at Indiana University for correlating weather conditions with traffic flow characteristics. These data are particularly valuable for performing the traffic flow studies concerning the following:
  - a. Speed distributions,
  - b. Headway distributions,
  - c. Platoon characteristics,
  - d. Traffic flow at the time of an accident, and
  - e. Effect of trucks (long-length vehicles) on a, through d. above.

- Several countermeasures (C/M's) have been recommended in the literature reviewed relative to control of vehicle speeds, use of appropriate traffic controls, and law enforcement techniques. Some of these countermeasures are listed below. These C/M's need to be studied for their potential pay-off in decreasing the likelihood of accident involvement for high-speed deviations. An approach for doing this is provided in Volume II.
  - a. Control of vehicle speeds
    - (1) Top speed limiting device,
    - (2) Performance freeze on speeds,
    - (3) Automatic car-following speed control.
  - b. Use of appropriate traffic controls
    - (1) Posting of both maximum and minimum speed limits,
    - (2) Posting of variable speed limits as a function of environmental conditions, for example, 35 mph on icy roads.
    - (3) Automated monitoring for traffic speed violations.
  - c. Law enforcement techniques
    - (1) Increased enforcement of speed limits, both minimum and maximum,
    - (2) Graded driver licensing, for example, restricting some older or physically handicapped drivers to non-high-speed roads,
    - (3) Automated speed monitoring and traffic violations.
- The continuous volume-time data for each of the sensor locations on Highway 37 can be utilized very effectively in developing and evaluating sampling procedures and techniques for estimating average annual daily traffic (AADT) and the speed distribution. Such a study is recommended in view of the current practices employed in estimating these important statistics. The development of efficient techniques for estimating the 85th percentile, or some other appropriate characteristic, of the speed distribution would aid in setting the speed limits.
  - Additional study needs to be made of the dependency of the likelihood of involvement on the road type. Also the errors in estimating the speeds of the accident-involved vehicles cannot be estimated with available data. It would be desirable to have such data in order to place confidence limits on the likelihoods given in the U-shaped distribution.

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations on this study have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

Availability: The above volumes may be ordered from NTIS, U.S. Department of Commerce, Springfield, Va. 22151. For Vol. I order DOT/HS-800 297 or PB-195 016; for Vol. II, order DOT/HS-800 297 or PB-195 017. Both in paper copy (PC) or microfiche (MF).

**U.S. DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION**

WASHINGTON, D.C. 20591

**OFFICIAL BUSINESS**

Penalty For Private Use, \$300



POSTAGE AND FEES PAID  
FEDERAL HIGHWAY ADMINISTRATION

**NHTSA REGIONAL OFFICES**

**Address**

Regional Administrator, NHTSA, Transportation Systems Center, 55 Broadway, Cambridge, Mass., 02142, Tel: 617-494-2681. (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont)

Regional Administrator, NHTSA, 4 Normanskill Blvd., Delmar, N.Y. 12054, Tel: 518-427-4095. (New Jersey, New York, and Puerto Rico)

Regional Administrator, NHTSA, Room 817 Federal Building, 31 Hopkins Plaza, Baltimore, Maryland 21021, Tel: 301-962-3878. (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia)

Regional Administrator, NHTSA, Suite 200, 1720 Peachtree Road, N.W., Atlanta, Georgia 30309, Tel: 404-526-3405. (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee)

Regional Administrator, NHTSA, 18209 Dixie Highway, Homewood, Illinois 60430, Tel: 312-799-6300. (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin)

Regional Administrator, NHTSA, 819 Taylor Street, Room 8442, Fort Worth, Texas 76102, Tel: 817-334-2021. (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas)

Regional Administrator, NHTSA, P.O. Box 7186, Country Club Station, Kansas City, Missouri 64113, Tel: 816-361-7887. (Iowa, Kansas, Missouri, and Nebraska)

Regional Administrator, NHTSA, Room 107, Bldg. 40, Denver Federal Center, Denver, Colorado 80225, Tel: 303-233-6429. (Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming)

Regional Administrator, NHTSA, 450 Golden Gate Avenue, Box 36096, San Francisco, California 94102, Tel: 415-556-5450. (Arizona, California, Hawaii, and Nevada)

Regional Administrator, NHTSA, Room 301, Mohawk Bldg., 222 S.W. Morrison Street, Portland, Oregon 97204, Tel: 503-226-3754. (Alaska, Idaho, Oregon, and Washington)